

Atty. Docket No.: MXIC 1516-1
Appl. No. 10/721,605

PATENT

Remarks

Claims 1 - 73 are in the application. Claims 71 - 73 have been withdrawn as being directed to a nonelected invention. Claims 1, 5 - 7, 23, 27, 28, 45 - 47, 51, 52, 69 and 70 are amended, and claims 4, 26 and 50 are canceled herein. No new matter is introduced by any of the amendments, and entry thereof is requested.

Claims 1 - 3, 5 - 25, 27 - 49 and 51 - 70 are under consideration in the application. Reconsideration of the application, as amended, is requested.

Applicants' invention features methods for forming an oxide in a semiconductor device having an ONO structure, by forming and patterning a tunnel oxide layer and a silicon nitride layer, and then concurrently forming a top oxide layer, a buried drain oxide layer, and a gate oxide layer by an *in situ* steam generation ("ISSG") process. The ISSG process entails heating the substrate to a selected temperature and exposing the patterned structure to an ambient including an oxygen-containing gas and a hydrogen-containing gas. Heating the substrate results in formation of a radical oxidizing agent (such as an oxygen radical) near the surfaces (*i.e.*, "*in situ*") of the patterned structure. As a result the oxidation of the silicon nitride can be effected in a very short time, and at a reduced thermal budget.

The points raised by the Examiner will now be addressed.

Rejections under 35 U.S.C. §102(e) and 35 U.S.C. § 103(a) over Yoo

Claims 1 - 4, 8 and 16 were rejected under 35 U.S.C. §102(e) as being anticipated by Yoo *et al.* U.S. 2004/0009642 ("Yoo"); and claims 5 - 7 and 9 - 15 were rejected under 35 U.S.C. §103(a) for obviousness over Yoo.

The Examiner stated, as to claim 1, that Yoo describes a method for forming an ONO structure, by providing an oxide-nitride film on a surface of a substrate, the oxide-nitride film including a first oxide layer over the substrate and a silicon nitride layer over the first oxide layer; patterning the oxide-nitride film to define bottom oxide and silicon nitride portions of an ONO stack, the bottom oxide and silicon nitride portions having exposed sidewalls and the silicon nitride portion having an exposed surface; and exposing the oxidized sidewalls and the exposed surface to a rapid thermal oxidation in an ambient containing a radical oxidizing agent to form an

Atty. Docket No.: MXIC 1516-1
Appl. No. 10/721,605

PATENT

oxide layer on the expose surface and sidewalls of the patterned silicon nitride portion and on the sidewalls of the patterned bottom oxide portion.

As to claims 4 and 8 the Examiner stated further that Yoo describes "heating the substrate to a selected temperature and exposing the exposed sidewalls and the exposed surface to a mixture of O₂ and H₂ in a selected proportion at a selected pressure and for a selected time, whereby components of the O₂ and H₂ react to produce O* near the surface." Applicants disagree that Yoo teaches heating the substrate; Yoo does not teach or suggest an ISSG process, by heating the substrate, as in Applicants' invention as claimed in amended claim 1 (and claims 23 and 47). Yoo describes loading the semiconductor substrate having the NO layer into a reaction chamber and "generating oxygen radicals O* in the reaction chamber. ... Radical oxidation may be performed using plasma or may be performed by high-temperature wet oxidation so as to generate oxygen radical O* (Yoo, paragraph [0023]). ... When using high-temperature wet oxidation, while maintaining the temperature of and pressure applied to a high-temperature reaction chamber ... reaction gas for oxidation ... is inserted into the reaction chamber ... (Yoo, Paragraph [0027])."

Claim 1 is amended to incorporate the limitations of claim 4, to recite that the method according to the invention includes an *in situ* ISSG oxidation, and thereby clearly distinguishing Yoo. Claims 2, 3, 8 and 16 depend from amended claim 1, and claims 5 - 7 are amended to depend from claim 1; claims 9 - 15 depend from 1 through claim 8; and claim 4 is canceled herein.

Accordingly, the rejections of claims 1 - 4, 8 and 16 for anticipation by Yoo, and the rejections of claims 5 - 7 and 9 - 15 for obviousness over Yoo, can now be withdrawn.

Further rejections under 35 U.S.C. § 103(a)

Claims 17 - 18 and 20 - 22 were rejected under 35 U.S.C. §103(a) for obviousness over Yoo in view of Ikakura *et al.* U.S. 6,255,230 ("Ikakura").

The Examiner acknowledged that Yoo does "not explicitly teach flowing the mixture of O₂ and H₂ further comprises flowing N₂ as a carrier gas." Ikakura was relied upon as teaching N₂ gas as a carrier gas. The Examiner argued that it would have been obvious to use N₂ as a carrier gas "since the carrier gas may help flowing an oxygen radical hence improving the oxide layer quality." The rejection is traversed, in view of the amendment of claim 1, from which claims 17 - 18 depend, indirectly. It is noted that, according to the *in situ* process employed in Applicants' invention, the oxygen radical is formed by reaction of the H₂ and O₂ at the wafer surface (*see, e.g.*, Applicants' paragraph [0030]), so that it is not necessary to "flow" the oxygen radical. No

Atty. Docket No.: MXIC 1516-1
Appl. No. 10/721,605

PATENT

combination of Ikakura with Yoo describes or suggests Applicants' claimed combination including an *in situ* ISSG oxidation to form the oxide layer concurrently on the upper surface and sidewalls of the SiN layer, a buried diffusion in the substrate, and a gat oxide layer on the MOS region of the substrate.

Accordingly, the rejection of claims 17 - 18 and 20 - 22 can be withdrawn.

Claims 23 - 37, 40, 42, 44 - 61, 64, 66 and 68 - 70 were rejected for obviousness over Yoo in view of Applicants' disclosure in background, and claims 38 - 39, 41 - 43, 63 - 63, 65 and 67 were rejected for obviousness over Yoo in view of Applicants' disclosure in background ("APA") and further in view of Ikakura. Yoo and Ikakura are applied as in the rejections of claims depending directly or indirectly from claim 1. The Examiner acknowledges that Yoo does "not explicitly teach isolation to separate two regions." APA (Fig. 2) was relied upon as teaching "forming isolation region in the substrate to separate the substrate."

Independent claims 23 and 47 are amended herein, similar to the amendment of claim 1 as discussed above, to incorporate the limitations of claims 26 and 50, respectively, to recite that the method according to the invention includes an *in situ* ISSG oxidation. As discussed above, regarding claim 1, Yoo does not teach or suggest an ISSG process, by heating the substrate, as in Applicants' invention as claimed in amended claims 23 and 47 (and claim 1).

Accordingly, for at least the reasons set out above, no combination of Yoo, Ikakura, and APA describes Applicants' invention as claimed in claims 23 and 47, and accordingly, the rejections of these claims for obviousness can be withdrawn. Claims 26 and 50 are canceled herein; claims 27 and 28 are amended to depend from claim 23, and claims 51 and 52 are amended to depend from claim 47. (Claims 45, 46, 69 and 70 are amended for improved clarity.) All of claims 24, 25, 27 - 46 depend directly or indirectly from claim 23, and claims 48, 49, and 51 - 70 depend directly or indirectly from claim 47 and, accordingly, the rejections of all of claims 23 - 25, 27 - 49, and 51 - 70 can now be withdrawn.

In view of the foregoing, all the claims now under consideration in the application -- namely, claims 1 - 3, 5 - 25, 27 - 49, and 51 - 70 -- are in condition for allowance, and action to that effect is respectfully requested.

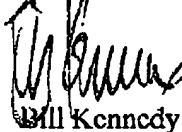
Atty. Docket No.: MXIC 1516-1
Appl. No. 10/721,605

PATENT

This Response is being filed within the shortened statutory period set by the Examiner for response to the Office action and, accordingly, it is believed that no extension of time is required in connection with this paper. In the event the Examiner may determine that an extension of time is required in connection with the filing of this paper, petition is hereby made therefor, and the Commissioner is authorized to charge any fee (or to credit any overpayment) to Deposit Account No. 50-0869 (MXIC 1516-1).

If the Examiner determines that a conference would facilitate prosecution of this application, the Examiner is invited to telephone Applicants' representative, undersigned, at the telephone number set out below.

Respectfully submitted,



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